Transphobia rather than education predicts provider knowledge of transgender health care

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PURPOSE Transgender and gender diverse (TGD) patients face significant hurdles in accessing affirming, knowledgeable care. Lack of provider knowledge presents a substantial barrier to both primary and transition-related care and may deter patients from seeking health care. Little is known about factors that affect provider knowledge or whether exposure to TGD health content during training is associated with improved knowledge among providers. Using the TGD Healthcare Knowledge Scale, this study aimed to determine whether prior education on TGD health predicts clinicians' current knowledge regarding health care for TGD patients.

METHODS An online survey examining exposure to TGD content and knowledge of TGD health care was distributed to all primary care providers in an integrated health care system in the Midwestern United States. Multivariable linear regression was used to predict provider knowledge, controlling for demographics, transphobia and other potential confounders.

RESULTS The response rate was 57.3% (n = 223). The mean knowledge score was 7.41 (SD = 1.31) on a 10-point scale. Almost half (48.4%, n = 108) had no formal education on TGD health care, yet half (49.7%, n = 111) of providers reported previously caring for at least one transgender patient. In regression analysis, provider knowledge of TGD health care was associated with transphobia ($\beta = -0.377$, 95% CI = −0.559 to −0.194, $p < 0.001$), but not with hours of formal education ($\beta = -0.027$, 95% CI = −0.077 to 0.023, $p = 0.292$) or informal education ($\beta = -0.012$, 95% CI = −0.033 to 0.009, $p = 0.259$).

CONCLUSIONS Increasing hours of education related to TGD health care may not be sufficient to improve providers' competence in care for TGD individuals. Transphobia may be a barrier to learning that needs to be addressed. Broader efforts to address transphobia in society in general, and in medical education in particular, may be required to improve the quality of medical care for TGD patients.

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INTRODUCTION

Transgender and gender diverse (TGD) people comprise 0.5–0.6% of adults in the USA.[1] This population faces multiple barriers accessing health care services,[2] which may contribute to significantly increased rates of morbidity and mortality.[3] Compared to cisgender individuals, TGD people suffer poorer health outcomes that largely stem from societal discrimination and violence.[3] For example, rates of serious psychological distress in this population are 39%, compared to 5% in the general population.[2] TGD people have a 40% lifetime suicide attempt rate, nine times that of the general US population.[2] Many of these disparities arise from systemic transphobia (bias towards transgender people) within society, including hurdles within the health care system, such as discrimination, harassment, and the inability to find a knowledgeable and affirming provider.[4,5] TGD people often avoid needed medical care because of fear of mistreatment.[6] Lack of provider knowledge has emerged as a leading factor in TGD individuals' inability to access appropriate care, with 33% reporting having to teach their medical providers about TGD health care[2]; this factor was found to be significantly associated with care delay or avoidance.[7]

Primary care providers (PCPs), including practitioners of family medicine, general internal medicine or obstetrics and gynaecology,[8] play a central role in increasing TGD people's access to care and reducing their health care costs[9] through preventive care, coordinating with affirming specialists, addressing health disparities and providing gender-affirming hormones. Other specialties, such as paediatrics and emergency medicine, may play similar roles for younger patients, in acute situations, or as a safety net for patients who are unable to access primary care.

Descriptive studies reveal that medical education, both graduate and postgraduate, on TGD health care tends to be absent or minimal.[10–14] Many providers lack the knowledge, skills or willingness to care for TGD patients.[15,16] Professional associations, including the Institute of Medicine,[17] the Association of American Medical Colleges[18] and the American College of Obstetricians and Gynecologists,[19] have identified the need to improve provider knowledge in the care of TGD people.

Educational programmes such as medical student or resident elective rotations show promise by increasing knowledge and comfort among programme participants.[20–22] However, research regarding practising PCPs' knowledge of TGD health care, and ways to improve such knowledge, is lacking. Moreover, prior studies have mostly used subjective outcomes (e.g. comfort level in treating TGD patients[15,22,23]), rather than objective and reproducible measures, as indicators of knowledge. Additionally, little is known about provider or educational factors associated with TGD care knowledge. Such data are crucial to the development of effective educational interventions.

Based on prior research,[6,11,22–25] we hypothesized that personal factors, including prior contact with and attitudes towards transgender people, as well as educational exposure, are associated with TGD health care knowledge (Fig. 1, conceptual model). Using an objective knowledge scale created for the study, the TGD Healthcare Knowledge Scale, we explored PCPs' knowledge of TGD health care. Specifically, we aimed to determine whether formal education on TGD health predicts knowledge regarding care for TGD patients, while controlling for provider characteristics, personal and clinical contact, informal education and transphobia.

METHODS

Study design

A cross-sectional online survey was distributed to all adult outpatient PCPs (the population for whom the knowledge scale was designed) within a large Midwestern US integrated health system. Eligible participants (n = 389) included attending physicians, advanced practitioners and residents from the departments of internal medicine, family medicine and obstetrics and gynaecology.

Procedures

Health system records were used to identify eligible providers. A survey link was sent by electronic mail with up to two reminders to non-respondents. Participants received a $30 gift card and were entered into a draw to receive one of three $100 gift cards. Data were collected and stored using the secure Research Electronic Data Capture (REDCap) software.[26,1] All data were de-identified prior to

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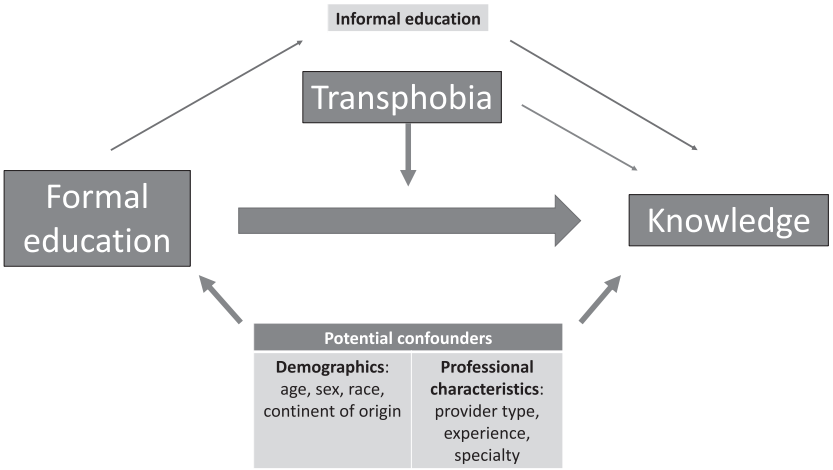

Figure 1 Conceptual model. A model of hypothesised relationships between the outcome and predictor variables and major potential confounders. The conceptual model, informed by prior literature,[6,11,21–25,28] was used in construction of the regression models. We hypothesised that increased hours of formal education would lead to greater knowledge, as expressed by a higher score on the TGD Healthcare Knowledge Scale. This relationship may be confounded by participant characteristics, informal education and transphobia, which we controlled for in the model. Transphobia was hypothesised to moderate the effect of education on knowledge, with increased transphobia decreasing the effect. Models with and without informal education were evaluated, given potential correlation with both formal education and knowledge. Because of the cross-sectional nature of our study, causality cannot be inferred from our results

analysis. The study was approved by the health system's Institutional Review Board.

Measures

We used measures from four domains: (i) knowledge of issues pertaining to caring for TGD patients, the outcome variable; (ii) exposure to TGD people and educational content; (iii) transphobia; and (iv) provider characteristics. The survey consisted of 66 items. All researcher-created items were pilot tested for clarity and appropriateness with a small sample of providers with and without experience in TGD patient care, from the specialties included in the study. Changes were made based on feedback.

Outcome variable

The TGD Healthcare Knowledge Scale (Appendix S1) was constructed for this study, in consultation with experts in the field and based on training assessment questionnaires.[27,28] The 12-item scale explored knowledge in three domains relevant to core competencies in primary care for TGD individuals.[29] Four questions assessed social aspects of TGD health care (e.g. pronoun use and social determinants of health), as understanding those aspects has been deemed essential to culturally appropriate interaction with TGD patients; two questions evaluated preventive care (breast cancer screening and mental health) of TGD people; and six questions evaluated knowledge regarding transition-related care, including hormone prescription and criteria for surgery, based on widely used published guidelines.[30–32] We divided the number of correct answers by 12, and multiplied the result by 10, in order to create a knowledge score on a scale of 0–10. Higher score reflects greater knowledge. Unanswered questions were scored as incorrect.

Predictor variable

Formal educational exposure was measured as the number of hours of transgender health education received as part of one's clinical training ('About how many hours of formal education about transgender health have you had in a medical educational setting (i.e. medical school, nursing or PA school, residency, CME, CEU, etc.)?').

Control variables

Informal educational exposure was measured as the number of hours of self-directed learning (e.g. reading) about transgender health the respondent had undertaken.

Contact was evaluated in two areas, personal and clinical, and questions were adapted from prior studies.[22,24] Personal contact was measured using

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the question 'Have you ever met a transgender person?' Clinical contact was evaluated using two questions: whether the provider was currently caring for a transgender patient and whether they had cared for one in the past 5 years.

Provider characteristics were medical specialty, experience (years in practice) and provider type (resident, advanced practitioner or attending physician), as well as demographics including age, sex/gender, race/ethnicity, sexual orientation, continent of origin, religious identity, religiosity and political views. Continent of origin was assessed using the question 'Where did you attend high school?' (as high school is often tightly linked to acculturation).[33] Religious identity was categorised as atheist or agnostic, Christian, Muslim, Jewish, Hindu and Other. Religiosity was measured using the question 'To what extent do you consider yourself a religious person?' with a 4-point Likert scale (1 = not at all religious; 4 = very religious). Political views were categorised as liberal, moderate or conservative.

Transphobia was measured by an 8-item scale (Appendix S2), which was adapted from a previously validated scale assessing gender differences in correlates of transphobia.[34] Respondents answered using a seven-point Likert scale (1 = strongly disagree; 7 = strongly agree). A transphobia score was calculated as a mean of the score for answered questions (range 1–7), with higher scores indicating a greater degree of transphobia. Respondents missing >25% of the items were excluded from the analysis (Cronbach's α, 0.847).

Analysis

We analysed data using Stata SE, version 14.0 (StataCorp, College Station, TX, USA). Descriptive statistics were generated for all study variables. Bivariate linear regressions were used to estimate mean differences in knowledge score by each predictor and control variable.

We used multivariable linear regression to examine associations between educational exposure (number of hours of formal education) and knowledge scores, while controlling for potential confounders. Alpha was set at .05.

Confounders were added to the regression model based on our conceptual model (Fig. 1)[6,11,21–25,28] and included demographics (age, sex, race and continent of origin)[6,22–24] and other provider characteristics (provider type, specialty and experience [years in practice]),[11,25] that were likely to affect both the predictors and the outcome. The model was also controlled for self-directed (informal) education, given the anticipated correlation with the outcome, with a potential confounding effect amongst providers who opted into elective educational programming. We tested for transphobia as a potential moderator of the effect of education on knowledge using an interaction term. We used Stata margins for probability predictions. Gender identity and sexual orientation were not included as controls because of the low prevalence of gender and sexual minority groups in our sample. Additionally, personal and clinical contact, as well as religion and political view variables, were theorised to have a potential effect on transphobia and knowledge,[35,36] but not directly on the primary predictor (hours of formal education) or on the predictor–outcome relationship. We tested for the effect of these variables on the model, but they did not significantly change our final results and were not included in the final regression model.

Respondents who answered fewer than 10 of the 12 knowledge questions were excluded from analysis. The sample was not large enough for imputation. For the education (formal and informal) variables, outliers more than two standard deviations away from the mean were excluded (24 hours of formal education reported, $n = 10$; and 152 hours of informal education reported, $n = 3$, respectively). These extreme cases would have had significant leverage on the regression results and are not in a range that would be practical from the perspective of educational curriculum development. Hence, analysis without outliers was performed, ensuring that any associations found would be both reliable and generalizable to a broad group of learners.

RESULTS

Demographics

A total of 223 respondents (57.3%) completed the survey. The mean age was 41.3 years (SD 13.57). More than half (59.2%, $n = 132$) of the respondents were female and 55.6% ($n = 124$) were White. Approximately half (50.6%, $n = 113$) were internists, 22.4% ($n = 50$) were family physicians and 26.9% ($n = 60$) were obstetrician-gynaecologists. Respondents included attending

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physicians (47.5%, $n = 106$), residents (42.1%, $n = 94$) and advanced practitioners (physician assistants and nurse practitioners; 10.3%, $n = 23$). A majority (69.7%, $n = 154$) had completed their high school education in North America or the Caribbean.

Outcome and primary predictors

A TGD Healthcare Knowledge Score was calculated for 203 (91.0%) of the respondents; the mean score was 7.41 (SD = 1.31) on a scale of 1–10. The mean number of hours of formal education on transgender health care was 2.49 (SD = 4.41); for informal education, it was 6.13 hours (SD = 12.41).

Half (50.2%, $n = 111$) of the providers had cared for at least one transgender patient in the past 5 years. The mean transphobia score was 3.06 (SD = 1.09), indicating that on average, respondents had moderate levels of transphobia, responding that they "somewhat disagree" with transphobic statements (Table 1).

Bivariate associations

The TGD Healthcare Knowledge Scale scores were not significantly associated with formal educational exposure ($\beta = -0.040$, SE = 0.022, $p = 0.067$) (results not shown), nor with sex, age, type of provider, experience of provider or informal education. They were significantly associated with race ($p = 0.019$ for the overall difference); the difference was attributable to the Asian and White comparison, with the average TGD Healthcare Knowledge Score 0.669 points lower among Asian respondents compared to White respondents (SE = 0.212, $p = 0.002$). Respondents who attended high school in North America had higher scores than those who attended elsewhere ($\beta = 0.813$, SE = 0.195, $p < 0.001$). Scores were higher among obstetrician-gynaecologists, by 0.506 points (SE = 0.216, $p = 0.02$) and 0.775 points (SE = 0.262, $p = 0.003$) compared to internists and family physicians, respectively. People who identified as atheist had higher scores than those who were religiously identified ($\beta = 0.813$, SE = 0.320, $p = 0.012$), and those who had liberal political views had higher scores than those with conservative views ($\beta = 0.849$, SE = 0.262, $p = 0.001$). Respondents who had met a transgender person had higher scores by 0.469 points than those who had not (SE = 0.218, $p = 0.033$). Higher transphobia scores predicted lower TGD Healthcare Knowledge Scores ($\beta = 0.491$, SE = 0.079, $p < 0.0001$).

Multivariable regression

The overall multivariable regression model was statistically significant ($p < 0.0001$, adjusted $R^2 = 0.1859$) (Table 2). Number of hours of formal education was not associated with the level of knowledge ($\beta = -0.027$, 95% CI −0.077 to 0.023, $p = 0.292$). Only transphobia predicted the TGD Healthcare Knowledge Score ($p < 0.001$). Controlling for both formal and informal education and other confounders, for each 1-point increase in the transphobia score, the TGD Healthcare Knowledge Score decreased by 0.377 (95% CI = −0.559 to −0.194). We tested whether transphobia moderated the relationship between formal education and knowledge. The interaction effect was not significant and was not included in the final model.

DISCUSSION

We found that half of the providers surveyed had cared for transgender patients but a majority of respondents had received no more than minimal education on the topic. This finding is consistent with previous studies showing low rates of provider education on TGD care.[11,12,14,23] However, we found that increased hours of education (whether formal or informal) were not associated with improved knowledge. The only factor in the multivariable model predicting knowledge was transphobia. This is the first study to our knowledge to show a negative association between transphobia and objectively measured provider knowledge. This result is a concerning addition to the accumulating literature regarding transphobia as a major barrier to knowledgeable provision of care. As described by McPhail and colleagues, 'education alone that simply fills gaps in knowledge without addressing the systematically socialized transphobia of healthcare professionals . . . will not likely be effective'.[37]

Previous studies that have evaluated the effectiveness of educational efforts to improve transgender health knowledge among providers have reported mixed findings. In a Canadian study, medical students who were exposed to transgender-health curricular content had similar knowledge to students who did not have such curricula content.[12] In Safer and Pearce's study, some student groups, but not all, showed a decrease in anticipated discomfort in treating transgender patients, following a curricular addition,[22] and notably, there was no change in the proportion of students believing that transgender care was not a part of conventional medicine. In

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Table 1 Provider characteristics and study variables

Categorical variables	*n* (%)
Gender	
Male	90 (40)
Female	132 (59)
Race	
White	124 (55.6)
African American	17 (7.6)
Asian	60 (26.9)
Other	22 (9.8)
Continent of origin	
North America/Caribbean	154 (69)
Other	69 (31)
Specialty	
Internal medicine	113 (50.6)
Family medicine	50 (22.4)
Obstetrics/gynaecology	60 (26.9)
Experience (years in practice)	
Resident	94 (42.1)
0–4	16 (7.1)
5–9	24 (10.7)
10–14	14 (6.2)
15–19	13 (5.8)
>20	62 (27.8)
Provider type	
Resident	94 (42.1)
Advanced practitioner	23 (10.3)
Attending MD	103 (47.5)
Religion	
Christian	110 (49.3)
Muslim	38 (17)
Hindu	27 (12)
Atheist	19 (8.5)
Jewish	13 (5.8)
Other	16 (7.1)
Religiosity	
Not at all religious	44 (19.7)
Slightly religious	48 (21.5)
Moderately religious	105 (47)
Very religious	26 (11.6)
Political views	
Conservative	38 (17)
Moderate	81 (36.3)
Liberal	104 (46.6)
Has met a transgender person	
Yes	173 (78)
No	50 (22)

Table 1 (Continued)

Categorical variables	*n* (%)
Transgender patient in past 5 years	
Yes	111 (49.7)
No	112 (51.3)
Currently have a transgender patient	
Yes	56 (25.11)
No	167 (74.8)
Continuous variables	**Mean (SD, median)**
Age	41.3 (13.57, 37.5)
TGD Healthcare Knowledge Score*	7.41 (1.31, 7.5)
Transphobia†	3.06 (1.09, 3)
Informal education	6.13 (12.41, 2)
Formal education	2.49 (4.41, 0)

* TGD Healthcare Knowledge Score range, 0–10.
† Transphobia score range, 1–7.

other studies, results showed improvement in trainee competence.[21,38] However, these studies evaluated short-term, self-reported outcomes of educational interventions such as clinical exposure and online modules.[21,22,38] For example, medical students who participated in an elective on transgender health had improved self-assessed knowledge, skills and comfort in caring for transgender patients *immediately* following the elective[21]; trainees in paediatrics showed an improvement in their *perceived* knowledge following a transgender youth curriculum.[38] Our study uses objectively measured knowledge amongst practising providers, rather than short-term recollection following an intervention (which may not represent long-term knowledge retention). This additional feature may explain our unique findings.

Limitations

Our study has several limitations. The cross-sectional nature of this survey prohibits us from making causal inferences. Generalisability of the findings from this study may be limited by respondent selection bias. Selection bias is likely to have favoured responses by less transphobic respondents, which may have attenuated the association we found between transphobia and knowledge. Additionally, our survey respondents, although professionally and demographically diverse, were all employed by one

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Table 2 Coefficients for predictors of TGD Healthcare Knowledge Score adjusted for confounders in a multivariable linear regression

Coefficients	β	95% CI	p value
Formal education	−0.027	−0.077 to 0.023	0.292
Confounders			
Transphobia	−0.377	−0.559 to −0.194	**<0.001**
Informal education	−0.012	−0.033 to 0.009	0.259
Age	0.0003	−0.038 to 0.039	0.988
Sex (compared to men)			
Women	−0.336	−0.726 to 0.053	0.090
Race (compared to white)			
African American	0.036	−0.67 to 0.74	0.919
Asian	−0.255	−0.716 to 0.205	0.275
Other	−0.006	−0.66 to 0.65	0.985
Continent of origin (compared to North America)	0.44	−0.012 to 0.9	0.056
Specialty (compared to internal medicine)			
Family medicine	−0.249	−0.727 to 0.229	0.305
Obstetrics/gynaecology	0.389	−0.095 to 0.873	0.115
Provider type (compared to residents)			
Advanced practitioner	−0.012	−0.91 to 0.886	0.979
Attending	0.073	−0.599 to 0.745	0.830
Experience (years, compared to <10)			
10–20	0.282	−0.465 to 1.03	0.458
>20	−0.351	−1.33 to 0.623	0.478

$p > F < 0.0001$, adjusted $R^2 = 0.1859$.

health care system, thereby limiting generalisability. Our results are also not generalisable to other providers caring for TGD patients, such as paediatricians and emergency providers.

Our measure of educational exposure only assessed hours spent and not content areas addressed. Future research should investigate particular types of educational interventions or collect information about key content areas.

Interventions to improve knowledge and competence

Recent years have seen a sharp rise in awareness of TGD people's health care needs, as well as acknowledgment of current gaps in medical education on the topic. An increasing number of medical education programmes are instituting training on transgender health.[22,28,38,39] These are timely efforts to address a dire need. As educators and others work toward improving provider competence in TGD care, it is important to acknowledge that the effectiveness of such programmes may depend not only on increasing informational knowledge, but also on addressing providers' biases, whether conscious or unconscious. Educational initiatives will need to take learners' backgrounds into account, directly address prejudice and enhance cultural humility. These efforts will resonate beyond TGD patients, to improve the readiness of trainees to provide care for a broad array of under-represented minorities and stigmatised populations. Prior studies show improved attitudes toward marginalised populations[40–42] following direct patient contact, experiential training[43,44] and standardised patient encounters.[45] Specific to transphobia, research highlights the utility of fostering understanding and awareness of transgender issues through a webinar in reducing biased attitudes among undergraduate students and mental health practitioners and trainees.[46] Exploring the effectiveness of a webinar for PCPs is recommended.

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Some surprising results emerged, which may be related to the design and focus of our study. We did not find an association between social contact and professional exposure to transgender people and knowledge, which may be a result of the retrospective nature of our study and the fact that we did not assess the effects of a specific, educational encounter. In addition to formal curricula to address implicit bias in medical education,[47] many have stressed the importance of addressing informal instruction (or 'the hidden curriculum', including institutional culture) in medicine in order to decrease implicit bias.[48–50] Interventions that address norms,[51] such as increasing medical student diversity, experiences that promote empathy and role modelling, have been suggested specifically in caring for stigmatised populations.[52] Finally, in our efforts to improve the care of TGD patients through decreasing implicit bias, we should remember that transphobia in medicine is not simply a reflection of societal transphobia. Rather, the construction of current social conceptions of gender and sex as binary, permanent and objectively identifiable, derive directly from the psychiatric construction of transgender identity as a distinct, pathological and medicalised entity.[53] Thus, addressing the root causes of transphobia as they relate to medical culture requires reconceiving the role of medicine in the construction of gender and gender diversity.[54] It is therefore also possible that addressing the culture of medicine will likewise have positive effects on decreasing societal transphobia.

As new forms of interventions are developed, evaluations must assess long-term outcomes, ideally utilising objective knowledge measures, as we have used in this study, as well as incorporating patient-reported outcomes. Future studies should further operationalise formal education by asking about participation in particular types of training.

The eventual goal of medical education is the improvement of health outcomes. Although direct measurement of the effects of education on these outcomes is a complex endeavour, the evaluation of proxy measures should be enhanced. This would include assessment of patient engagement in care and, importantly, patient-reported outcomes. Using community-based participatory approaches in the development of educational interventions may have the dual effect of bringing patient insights to medical education, as well as engaging TGD individuals and empowering them to take part in their own health and care.

CONCLUSIONS

We found that increased hours of education were not associated with improved provider knowledge of transgender health care. The only factor predicting knowledge in the overall model was transphobia. Research is needed to evaluate which interventions are effective in increasing knowledge and ultimately lead to improved care.

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Note

1. REDCap is a secure, web-based application designed to support data capture for research studies, providing (i) an intuitive interface for validated data entry; (ii) audit trails for tracking data manipulation and export procedures; (iii) automated export procedures for seamless data downloads to common statistical packages; and (iv) procedures for importing data from external sources.

REFERENCES

1 Flores AR, Herman JL, Gates GJ, Brown TNT. *How Many Adults Identify as Transgender in the United States?*. Los Angeles, CA: The Williams Institute 2016.
2 James SE, Herman JL, Rankin S, Keisling M, Mottet L, Anafi M. *The Report of the 2015 U.S. Transgender Survey.*

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Washington, DC: National Center for Transgender Equality 2016.
3 Stroumsa D. The state of transgender health care: policy, law, and medical frameworks. *Am J Public Health* 2014;**104** (3):e31–8.
4 Samuels EA, Tape C, Garber N, Bowman S, Choo EK. "Sometimes you feel like the freak show": a qualitative assessment of emergency care experiences among transgender and gender-nonconforming patients. *Ann Emerg Med* 2019;**71** (2):170–82.e1.
5 Shires DA, Jaffee K. Factors associated with healthcare discrimination experiences among a national sample of female-to-male transgender individuals. *Health Soc Work* 2015;**40** (2):134–41.
6 White Hughto JM, Murchison GR, Clark K, Pachankis JE, Reisner SL. Geographic and individual differences in healthcare access for U.S. transgender adults: a multilevel analysis. *LGBT Health* 2016;**3** (6):424–33.
7 Jaffee KD, Shires DA, Stroumsa D. Discrimination and delayed healthcare among transgender women and men: implications for improving medical education and healthcare delivery. *Med Care* 2016;**54** (11):1010–6.
8 Unger CA. Caring for the transgender patient: the role of the gynecologist. *OBG Manag* 2017;**29** (6):31–8.
9 Buchholz L. Transgender care moves into the mainstream. *JAMA* 2015;**314** (17):1785–7.
10 Obedin-Maliver J, Goldsmith ES, Stewart L, White W, Tran E, Brenman S, Wells M, Fetterman DM, Garcia G, Lunn MR. Lesbian, gay, bisexual, and transgender-related content in undergraduate medical education. *JAMA* 2011;**306** (9):971–7.
11 Unger CA. Care of the transgender patient: a survey of gynecologists' current knowledge and practice. *J Womens Health (Larchmt)* 2015;**24** (2):114–8.
12 Chan B, Skocylas R, Safer JD. Gaps in transgender medicine content identified among Canadian medical school curricula. *Transgend Health* 2016;**1** (1):142–50.
13 Noonan EJ, Sawning S, Combs R, Weingartner LA, Martin LJ, Jones VF, Holthouser A. Engaging the transgender community to improve medical education and prioritize healthcare initiatives. *Teach Learn Med* 2018;**30** (2):119–32.
14 Moll J, Krieger P, Moreno-Walton L, Lee B, Slaven E, James T, Hill D, Podolsky S, Corbin T, Heron SL. The prevalence of lesbian, gay, bisexual, and transgender health education and training in emergency medicine residency programs: what do we know? *Acad Emerg Med* 2014;**21** (5):608–11.
15 Chisolm-Straker M, Willging C, Daul AD, McNamara S, Sante SC, Shattuck DG 2nd *et al*. Transgender and gender-nonconforming patients in the emergency department: what physicians know, think, and do. *Ann Emerg Med* 2018;**71** (2):183–8.e1.
16 Shires DA, Stroumsa D, Jaffee KD, Woodford MR. Primary care providers' willingness to continue gender-affirming hormone therapy for transgender patients. *Fam Pract* 2018;**35** (5):576–81.
17 Institute of Medicine (US) Committee on Lesbian, Gay, Bisexual, and Transgender Health Issues and Research Gaps and Opportunities. *The Health of Lesbian, Gay, Bisexual, and Transgender People: Building a Foundation for Better Understanding*. Washington, DC: National Academies Press (US) 2011.
18 AAMC Advisory Committee on Sexual Orientation Gender Identity, and Sex Development. *Implementing Curricular and Institutional Climate Changes to Improve Healthcare for Individuals Who Are LGBT, Gender Nonconforming, or Born With DSD*. Washington, DC: Association of American Medical Colleges 2014.
19 Healthcare for Transgender Individuals. Committee opinion number 512. *Am College Obstetr Gynecol Obstet Gynecol* 2011;**118**:1454–8.
20 Fisher WS, Hirschtritt ME, Haller E. Development and implementation of a residency area-of-distinction in lesbian, gay, bisexual, and transgender mental health. *Acad Psychiatry* 2018;**42** (4):564–6.
21 Park JA, Safer JD. Clinical exposure to transgender medicine improves students' preparedness above levels seen with didactic teaching alone: a key addition to the Boston University model for teaching transgender healthcare. *Transgend Health* 2018;**3** (1):10–6.
22 Safer JD, Pearce EN. A simple curriculum content change increased medical student comfort with transgender medicine. *Endocr Pract* 2013;**19** (4):633–7.
23 Johnston CD, Shearer LS. Internal medicine resident attitudes, prior education, comfort, and knowledge regarding delivering comprehensive primary care to transgender patients. *Transgend Health* 2017;**2** (1):91–5.
24 Sanchez NF, Rabatin J, Sanchez JP, Hubbard S, Kalet A. Medical students' ability to care for lesbian, gay, bisexual, and transgendered patients. *Fam Med* 2006;**38** (1):21–7.
25 Wilson CK, West L, Stepleman L, Villarosa M, Ange B, Decker M, Waller JL. Attitudes toward LGBT patients among students in the health professions: influence of demographics and discipline. *LGBT Health* 2014;**1** (3):204–11.
26 Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)–a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;**42** (2):377–81.
27 Gorton N. *Questionnaire Following Clinical Training on Transgender Health*. San Francisco, CA: Project HEALTH 2014.
28 Kelley L, Chou CL, Dibble SL, Robertson PA. A critical intervention in lesbian, gay, bisexual, and transgender health: knowledge and attitude outcomes among second-year medical students. *Teach Learn Med* 2008;**20** (3):248–53.
29 Dubin SN, Nolan IT, Streed CG Jr, Greene RE, Radix AE, Morrison SD. Transgender health care: improving medical students' and residents' training and awareness. *Adv Med Educ Pract* 2018;**21** (9):377–91.
30 Center of Excellence for Transgender Care. *Guidelines for the Primary and Gender-Affirming Care of Transgender*

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and Gender Nonbinary People, 1st edn. Deutsch MB, editor. San Francisco, CA: Regents of the University of California 2011.
31 Coleman E, Bockting W, Botzer M, Cohen-Kettenis P, DeCuypere G, Feldman J *et al*. Standards of care for the health of transsexual, transgender, and gender-nonconforming people, version 7. *Int J Transgend* 2011;**13**:165–232.
32 Hembree WC, Cohen-Kettenis P, Delemarre-van de Waal HA, Gooren LJ, Meyer WJ 3rd, Spack NP, Tangpricha V, Montori VM. Endocrine treatment of transsexual persons: an endocrine society clinical practice guideline. *J Clin Endocrinol Metab* 2009;**94** (9):3132–54.
33 Erdal MB, Ezzati R. 'Where are you from' or 'when did you come'? Temporal dimensions in migrants' reflections about settlement and return. *Ethn Racial Stud* 2015;**38** (7):1202–17.
34 Nagoshi JL, Adams KA, Terrell HK, Hill ED, Brzuzy S, Nagoshi CT. Gender differences in correlates of homophobia and transphobia. *Sex Roles* 2008;**59** (7):521.
35 Chapman EN, Kaatz A, Carnes M. Physicians and implicit bias: how doctors may unwittingly perpetuate health care disparities. *J Gen Intern Med* 2013;**28**:1504–10.
36 Hill DB, Willoughby BLB. The development and validation of the genderism and transphobia scale. *Sex Roles* 2005;**53** (7–8):531–44.
37 McPhail D, Rountree-James M, Whetter I. Addressing gaps in physician knowledge regarding transgender health and healthcare through medical education. *Can Med Educ J* 2016;**7** (2):e70–8.
38 Vance SR Jr, Deutsch MB, Rosenthal SM, Buckelew SM. Enhancing pediatric trainees' and students' knowledge in providing care to transgender youth. *J Adolesc Health* 2017;**60** (4):425–30.
39 Eriksson SE, Safer JD. Evidence-based curricular content improves student knowledge and changes attitudes towards transgender medicine. *Endocr Pract* 2016;**22** (7):837–41.
40 Nelson ES, Krieger SL. Changes in attitudes toward homosexuality in college students: Implementation of a gay men and lesbian peer panel. *J Homosex* 1997;**33** (2):63–81.
41 Christison GW, Haviland MG. Requiring a one-week addiction treatment experience in a six-week psychiatry clerkship: effects on attitudes toward substance-abusing patients. *Teach Learn Med* 2003;**15** (2):93–7.
42 O'Toole TP, Hanusa BH, Gibbon JL, Boyles SH. Experiences and attitudes of residents and students influence voluntary service with homeless populations. *J Gen Intern Med* 1999;**14** (4):211–6.
43 Stone J, Moskowitz GB. Non-conscious bias in medical decision making: what can be done to reduce it? *Med Educ* 2011;**45**(8):768–76.
44 Burke SE, Dovidio JF, Przedworski JM, Hardeman RR, Perry SP, Phelan SM, Nelson DB, Burgess DJ, Yeazel MW, van Ryn M. Do contact and empathy mitigate bias against gay and lesbian people among heterosexual first-year medical students? A report from the medical student CHANGE study. *Acad Med* 2015;**90** (5):645–51.
45 Heron SL, Hassani DM, Houry D, Quest T, Ander DS. Standardized patients to teach medical students about intimate partner violence. *West J Emerg Med* 2010;**11** (5):500–5.
46 Mizock L, Hopwood R, Casey H, Duhamel E, Herrick A, Puerto G, Stelmach J. The transgender awareness webinar: reducing transphobia among undergraduates and mental health providers. *J Gay Lesbian Mental Health* 2017;**21** (4):292–315.
47 Leslie KF, Sawning S, Shaw MA, Martin LJ, Simpson RC, Stephens JE, Jones VF. Changes in Medical Student implicit attitudes following a health equity curricular intervention. *Med Teach* 2018;**40** (4):372–8.
48 Fallin-Bennett K. Implicit bias against sexual minorities in medicine: cycles of professional influence and the role of the hidden curriculum. *Acad Med* 2015;**90** (5):549–52.
49 Hernandez R. Medical students' implicit bias and the communication of norms in medical education. *Teach Learn Med* 2018;**30** (1):112–7.
50 Van Ryn M, Hardeman R, Phelan SM, *et al*. Medical school experiences associated with change in implicit racial bias among 3547 students: a medical student CHANGES study report. *J Gen Intern Med* 2015;**30** (12):1748–56.
51 Johnson MJ, May CR. Promoting professional behaviour change in healthcare: what interventions work, and why? A theory-led overview of systematic reviews. *BMJ Open* 2015;**5** (9):e008592.
52 Wear D, Kuczewski MG. Perspective: medical students' perceptions of the poor: what impact can medical education have? *Acad Med* 2008;**83** (7):639–45. 53.
53 Stryker S. *Transgender History*. Berkeley, CA: Seal Press 2008.
54 Fausto-Sterling A. *Sex/Gender: Biology in a Social World*. New York, NY: Routledge 2012.

SUPPORTING INFORMATION

Additional Supporting Information may be found in the online version of this article:

Appendix S1. Knowledge questions and correct response rate by item

Appendix S2. Gender attitudes scale (Transphobia scale)

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